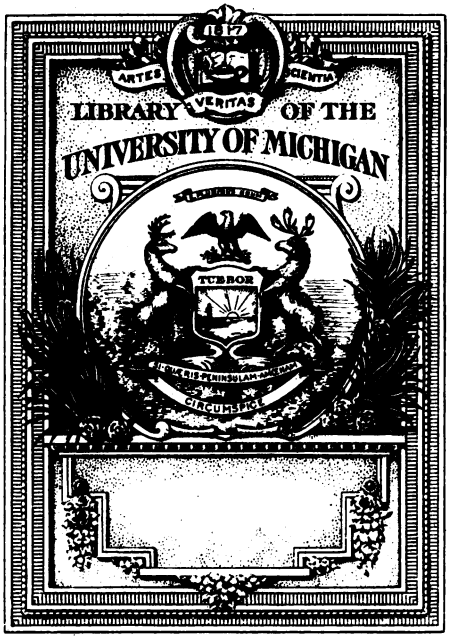

Drainage and Reclamation

OF

Swamp and Overflowed Lands

By
Charles Kettleborough

Indiana
Bureau of Legislative Information
Bulletin No. 2

April, 1914
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State House, Indianapolis

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INTRODUCTION.

This Bulletin, prepared by Charles Kettleborough of this Bureau, is designed to present in a brief, compact form the evolution, progress and present status of drainage and drainage legislation in Indiana; to enumerate and discuss the most significant results achieved in other states; to point out the inadequacy of our present system, the magnitude and economic importance of the question, the imperative need for state and national aid and supervision, and to suggest plans which it is believed will bring our drainage laws into harmony with those of the other states, render them less dilatory and more responsive, and afford the necessary instrumentality for the rapid and permanent reclamation of our non-arable swamp lands.

Considered purely as an economic question, as well as in its vital relation to the public health, this is a subject of paramount importance, involving a manifest public duty in the discharge of which, because of our imperfect and inadequate comprehension, we have been guilty of unconscious criminal neglect. There are 80,000,000 acres of unproductive swamp lands in the United States, a territory equal in extent to the combined area of Illinois, Indiana, Maine and Ohio, which is susceptible of profitable and permanent redemption.

In addition, there are 150,000,000 acres of arable lands which do not produce within 20% as much as they should because of insufficient drainage. These unprofitable, disease-breeding swamps, distributed over the entire national domain from the Atlantic to the Rockies and from the Lakes to the Gulf, constitute a national liability of several billions of dollars. To this incredible economic loss should be added an annual waste of $165,000,000 through the deaths, disability and loss of earning power due to malaria germs which flourish unchecked in these uncultivated areas.

Three states have approached this subject in a comprehensive, scientific and determined manner, and have already achieved results which have more than justified the predictions of the most sanguine advocates. Texas has added an average value of $25 to each acre of swamp lands within her spacious domains; Missouri has added $90,000,000 to the assessable value of her property within the brief space of 20 years; and it is confidently predicted that the redemption of the waste lands in Illinois will add $100,000,000 to the wealth of that state. During something more than a century, Indiana has reduced her swamp-land area by 2,500,000 acres and has added $68,000,000 to her assessable wealth. But even as late as 1910 the United States census reports disclosed that upwards of 1,000,000 acres were still unreclaimed, unproductive or only in a partial and uncertain state of cultivation. The annual loss to the state by reason of the existence of these waste and unproductive lands is admittedly $1,000,000. Surely the solution of this question by the extinction of this indefensible economic waste and the annexation of this extensive domain to our tax-paying assets should stimulate the imaginations and enlist the attention of constructive statesmen.

JOHN A. LAPP, Director.

CONTENTS.

GENERAL ASPECTS OF THE QUESTION.

REVIVAL OF INTEREST IN DRAINAGE. The past ten years have witnessed an extraordinary revival of interest in the drainage and reclamation of our non-arable swamp lands, and it is safe to predict that no movement will be attended with more beneficial or far-reaching consequences. The most characteristic phenomenon in American history has been the great westward movement of the population, and the assiduous and untiring pursuit of the elusive frontier. Some fifteen years ago one of our most eminent contemporary annalists announced that the frontier had finally been extinguished. This prediction was manifestly premature, as extensive unpreëmpted areas of non-arable swamp lands still exist to inspire these hardy adventurers to further conquest. The latent impulses of a restless and nomadic population were successively stirred by the irresistible attraction of Kansas and Nebraska, Minnesota and the Dakotas, Manitoba and her sister provinces, the irrigable, arid regions of the far west, and the cactus and mesquite plains of Texas. The resurgent flow of population and the permanent interruption of these pageants of land hunters were effectually induced about ten years ago by the all but complete preëmption of these western lands, the nominal extinction of the frontier, and the increase in the price of arable lands conveniently and advantageously located, and has been succeeded by the wholesome and salutary contemplation of the value and possibilities of the neglected swamp lands of the Mississippi valley and the South.

UNRECLAIMED LANDS IN THE UNITED STATES. The magnitude of the task of draining and reclaiming the overflowed and swamp lands in the United States, and those too wet for agricultural purposes, is not generally appreciated. According to the most reliable and authentic estimates

which have been made, there are at the present time upwards of 80,000,000 acres of these lands, capable of permanent and profitable redemption, about 60,000,000 acres of which are confined exclusively to the southern states. This desolate and submerged empire is equal in extent to the combined area of Illinois, Indiana, Maine and Ohio, and is almost three times as great as the superficial area of all New England. In addition to this, the Department of Agriculture has estimated that 150,000,000 acres of agricultural lands under cultivation are not producing within 20% as much as they should because of insufficient drainage.

ESTIMATED AREA OF UNRECLAIMED SWAMP AND OVERFLOWED LANDS IN THE UNITED STATES, RECLAIMABLE FOR AGRICULTURAL AND GRAZING PURPOSES.

State.	*Acres.*
Alabama	1,479,200
Arkansas	5,912,300
California	3,420,000
Connecticut	30,000
Delaware	127,200
Florida	19,800,000
Georgia	2,700,000
Illinois	925,000
Indiana	625,000
Iowa	930,000
Kansas	359,380
Kentucky	444,600
Louisiana	10,196,605
Maryland	192,000
Maine	156,520
Massachusetts	59,500
Michigan	2,947,439
Minnesota	5,832,308
Mississippi	5,760,200
Missouri	2,439,600

State.	*Acres.*
Nebraska	512,100
New Hampshire	12,700
New Jersey	326,400
New York	529,100
North Carolina	2,748,160
North Dakota	200,000
Ohio	155,047
Oklahoma	31,500
Oregon	254,000
Pennsylvania	50,000
Rhode Island	8,064
South Carolina	3,122,120
South Dakota	611,480
Tennessee	639,600
Texas	2,240,000
Vermont	23,900
Virginia	800,000
Washington	20,500
West Virginia	23,900
Wisconsin	2,360,000
Total	79,005,023

This gigantic extent of territory, capable of sustaining a population of fully 10,000,000 people and supplying homes of 40 acres each to 1,870,000 families, has been withdrawn from occupancy and cultivation because of the failure to adopt a systematic drainage plan which science and experience have demonstrated would be neither difficult nor costly. Engineers have estimated that the reclamation of the swamp lands of the South will result in greater benefit to the nation at large than the construction of the Panama Canal, since these lands are capable of sustaining a population of over 6,000,000 people.

REASONS FOR PROMOTING DRAINAGE. The reasons for promoting drainage enterprises are to better the public roads

and highways, to reclaim wet and overflowed lands or those subject to periodical submersion, to enhance the value of property, to improve the public health, and to promote the general welfare of the citizens.

FORMER OBJECTIONS TO DRAINAGE. Drainage has so abundantly proved itself to be both remunerative and beneficial that it is difficult to imagine that the question of its desirability should ever have been seriously discussed. Prior to 1860, however, a wide-spread and deep-seated hostility to any form of drainage prevailed, and this controversy, which had been waged with such incredible vigor, only subsided when the establishment of extensive and systematic experimental drains yielded unequivocal proof of their utility. And although drainage continued to receive increasing and well-merited attention and the attendant results were highly beneficial, it had not completely passed through the formative and experimental stage until 1880. Land was cheap and abundant and it was probably less expensive to appropriate unsettled, virgin territory than to redeem that subject to overflow. Moreover, the incontestable value of the chemical transformation wrought by drainage in rendering the soil friable and inducing a free and unobstructed circulation of air and moisture was ill understood by the early settlers. A few enterprising farmers in various parts of the country began draining their farms and were thereby enabled to plant their crops earlier and had actually increased the production two or three fold. This preliminary predatory warfare on water-logged soil gradually aroused public sentiment and recruits were slowly enlisted. The earliest results were so astonishing that even the most obdurate skeptics paid grudging and reluctant tribute to the achievements. Low-lands which had been considered permanently irreclaimable and unproductive, and had lain idle from time immemorial, were drained and cultivated with complete success. Perennial swamps, formerly covered with water to a depth of two or three feet, yielded from fifty to one hundred bushels of corn per acre within

a few years after the establishment of drains. The expense was so inconsiderable that the entire cost of drainage in many cases was fully repaid by the proceeds derived from the first crops grown.

Benefits of Drainage in Indiana. Fully 3,500,000 acres of land in this state, the most considerable portions of which are confined to the northwestern part, were originally swampy, non-arable, subject to periodical submergence, but capable of ultimate and permanent redemption. During the three-quarters of a century preceding 1880, the work of reclaiming these swamp lands had gone on so successfully and persistently that approximately 1,500,000 acres had been permanently reclaimed, leaving 2,000.000 wholly unredeemed or only in a partial and uncertain state of cultivation. The value of these wild and unsubdued lands as cow-pasture and sheep walks rarely exceeded four dollars per acre. All competent authorities agree that drainage increased their value to thirty dollars per acre, while the average annual production through lean and fruitful years, and considering their remoteness from fluctuating and uncertain markets, was fifteen dollars per acre. This calculation justifies the conclusion that the immediate value added to the total wealth of the state by the reclamation of these 1,500,000 acres was $45,000,000, while the combined value of the crops grown thereon during the thirty-three years which have elapsed since their redemption aggregates $22,500,000. Conversely, the annual loss which the state has successively sustained by the existence of these 2,000,000 barren and unproductive acres is $30,000,000. To further accentuate the magnitude and economic importance of this work, creditable statistics disclose that extensive drainage projects undertaken in the southwestern part of the state had redeemed 150,000 acres of the finest and most productive land in Knox county alone. Moreover, it was confidently asserted by capable and disinterested actuaries that the value of the 800,000 acres of waste lands situated in the Kankakee region could be increased $50,-

000,000 by promoting and securing their redemption, while the average annual production therefrom would aggregate $20,000,000.

PRESENT CONDITIONS IN INDIANA. Every year has witnessed fresh proofs of the value and recorded notable progress in drainage enterprises. But even as late as 1910, upwards of 1,000,000 acres were still unreclaimed, unimproved and unproductive. After allowing generously for the value of these waste lands for grazing purposes, the annual loss to the state by reason of their existence admittedly exceeds $7,000,000, a sum sufficiently large to pay the running expenses of this commonwealth for a year, or to completely extinguish the state debt twice over.

RESULTS OF DRAINAGE IN TEXAS. The swamp and overflowed lands of Texas cover about 5,000,000 acres, an area equal in extent to the states of New Jersey and Connecticut. These lands lie chiefly along the coastal plain and are perceptibly affected by the ebb and flow of the tide. The interior flood lands aggregate 3,000,000 acres. These undrained lands sell for from $10 to $20 an acre; when reclaimed they bring $50 or $60. The cost of drainage in no case exceeds ten or fifteen dollars. Lands which are under cultivation, but which are subject to an annual or semi-annual inundation, range in price from $5 to $25 per acre, depending on the frequency and severity of the floods to which they are subjected. The cost of constructing levees rarely if ever exceeds $25 per acre. The maximum cost in any case is $50 per acre. In the levee districts thus far completed the lands are valued at $75 per acre. The annual cost of maintenance and upkeep is inconsiderable.

RESULTS OF DRAINAGE IN MISSOURI. By the swamp land grant of 1850, approximately 3,346,000 acres of overflowed lands were patented to the state of Missouri, but the total unreclaimed area of that state aggregates 4,500,000 acres. In 1868, one body of land in that state, comprising 80,000 acres, sold for $664; the same tract of land is now worth

$8,000,000. At least three-fourths of the 2,572,800 acres comprising the seven southeastern counties of the state were originally unfit for human habitation, the timber was valueless, the public roads were impassable, and as late as 1890, some of this territory had no railroad. Towns and villages were scarce, and the metropolis of the region numbered only 2,178 inhabitants. The work of reclamation began in 1890, since which time 700,000 acres have been redeemed and rendered suitable for cultivation at a cost of from $3 to $6 per acre; the increase of population from 1890-1910 was 88.7%, while the increase in the rest of the state was only 20.7%. The assessed value of real estate increased 221%, while the increase in the rest of the state was only 76.5%. The railroad mileage increased over 200%, and the population of the towns from 250 to 1000%. The town which occupies the very center of this reclaimed area is said to be the richest town of its size in the United States. The value of the agricultural products shipped from this region in 1910 exceeded those shipped in 1890 two and one-third times. One million five hundred thousand acres in this region are still unreclaimed, but the work is being pushed rapidly forward. In one district, an expenditure of $121,000 netted a return of $1,442,500 in increased land values, an average of $58 per acre, and a return of $12 for every dollar expended. The improvements resulted in an increase of 75% in the yield of crops, which in two years time more than paid for the entire outlay. In another district, $66,405 spent for levees actually saved $654,000 worth of crops, and the construction of the levees added $1,280,625 to the value of the land, an average of $45 per acre, representing a return of $29 for every dollar expended, and for a period of 3 years every dollar spent for levees netted 460% on the investment. When drainage was instituted in the Little River Valley, timbered lands were selling for from $3 to $10 per acre; at the present time they are worth from $20 to $40 per acre, and similar lands at either side sell readily for from $75 to $125 per acre. In 1912, there were 197

drainage districts in the state whose combined area aggregated 3,546,186 acres, the total cost of which was $16,185,386.

It is estimated that if the swamp lands of Illinois were brought under cultivation they would add over $100,000,000 to the wealth of the state. In fact, the inexhaustible fertility of these lands and their value when reclaimed are frequently expressed in the maxim, "the wetter, the better."

DRAINAGE AND THE PUBLIC HEALTH. From the days when the adventurous pioneers first established settlements in the virgin territory and the primeval forests of the Mississippi valley, down to our own time, the public health has been exposed to constant peril from causes which the reclamation of the swamps and the cultivation of the land, and that alone, will effectually eradicate. In those early days the flood plains were so flat as to afford imperfect natural drainage, and the water which was deposited upon them by showers was left to stagnate or escape by evaporation. This rendered the atmosphere humid, misty and unwholesome, and, added to the decomposing vegetable matter, made the exhalations therefrom exceedingly deleterious. The drinking water was likewise seriously contaminated, and the inhabitants were visited by attacks of bilious and intermittent fevers, irregularities of the digestive organs, malaria, ague and headaches, which were not confined to the weak and aged, but attacked the young and robust. One of the most peculiar and prevalent maladies was a species of eruption, very painful and dangerous, accompanied by excessive irritation, and by a copious and poisonous suppuration, which accumulated and festered on the body of the patient. To add to the discomfort of the pioneers, the unreclaimed marshes bred noxious reptiles and insects. The bite or sting inflicted by these troublesome pests was highly poisonous and produced a painful inflammation. Cattle frequently died after eating the native grass or rushes which grew on the undrained reaches of the rivers.

The exhaustion of human vitality from malaria was appalling, and the mortuary records exhibit an astonishingly high percentage of deaths. The apothecaries and practitioners of 60 years ago were unable to successfully combat the inroads of this insidious enemy. Their sole remedy was quinine, which they administered to their patients in such generous quantities that the amount expended for that drug alone was almost equal to the amount paid for flour. It is now a demonstrable scientific fact that malaria is caused by the anopheles quadrimaculatus, a mosquito which flourishes in swampy regions and injects its poisoned virus by means of an exceedingly slender and attenuated proboscis. The female of the species lays many thousands of eggs in a season, and the rapidity of increase is incalculable. They thrive and multiply in hot weather, but if they are hermetically sealed up in a cake of ice all winter, they emerge in the spring as vigorous and destructive as ever. It was a near relative of this little insect which defeated the French so disastrously in their Panama undertaking under the renowned engineer, De Lesseps.

The tremendous havoc wrought by malaria, which is induced by this pernicious little pest, which flourishes only because there are swamps and flooded areas, was stated by Dr. Wm. A. Evans, former health commissioner of the city of Chicago, in an address before the National Drainage Congress at St. Louis, in April, 1913, when he asserted that the loss through malaria deaths amounts to $10,200,000 annually; the cost of disability and illness induced thereby, $92,000,000; the depreciation of real estate and loss in earning power of labor, due to malaria, $60,000,000; making an aggregate economic loss of $162,200,000 annually. In arriving at these conclusions, Dr. Evans frequently cut in half the generally accepted estimates.

The earliest experiments with drainage constituted unequivocal proof that when the land was drained bilious disorders, irregularities of the digestive organs, skin eruptions, ague, intermittent fever, malaria, inflammations, and

other plagues and pestilences, would disappear or become less troublesome. This longed-for desideratum was not realized in a single generation in this state, however, and these preventable miasmatic diseases but gradually disappeared. Even as late as 1879 there was not a county in the state which did not have considerable areas of standing water. In Jackson county alone it was estimated that fully 100 square miles of land were subject to overflow. Systematic drainage had demonstrated itself to be of such incontestable value that physicians estimated that fully one-third of all autumnal sickness could be prevented by this means alone. In 1880, White River township in Johnson county had a tolerably thorough system of tile drainage. So it was decided to institute an investigation in that township to ascertain the influence of drainage on the public health. Medical practitioners were requested to examine their books for data. Two periods of five years each were selected, and they were requested to state the number of patients under their care, during these two periods, whose ailments were directly traceable to miasmatic causes. The results of the investigation were significant and disclosed that miasmatic diseases were as prevalent as all others combined, and that for the five years from 1860-1864, inclusive, the total number of persons afflicted with this malady was 1,480; and for the five years from 1876-1880, inclusive, 490. During the first period designated, drainage had not been generally instituted; during the latter period, a fairly complete system of drainage had been established and perfected. It was further estimated that miasmatic diseases had decreased at least 60% during the decade preceding 1881, and for the period from 1864-1881 it was estimated that there had been a decrease of 40% due to drainage alone These facts produced such a profound impression on the public mind that influential citizens undertook, unsuccessfully, to induce the state to undertake the drainage of certain localities under the direction of medical and engineering experts.

PUBLIC SENTIMENT AND DRAINAGE LEGISLATION. Since the burden of draining and reclaiming the swamp lands must rest ultimately on the people themselves, it is necessary to arouse public sentiment, to emphasize the economic value of drainage and to provide a convenient instrument by which public opinion may be effectually carried out. Much work has already been done along this line. Every state in the Union, with the possible exception of Alabama, has a drainage law; many states have adopted them recently; in most states they have been on the statute books for many years, and in at least one New England state, they date back to 1636. These laws, however, are incomplete, ineffective, and there is a bewildering lack of uniformity in their provisions. They should be standardized and simplified and co-operation among the several states should be vigorously promoted. The imperative need is for the adoption of a uniform drainage and levee law, not only clear enough to be understood but so clear that it cannot be misunderstood; this method of procedure will then become fixed in the public mind, and when its constitutionality is unequivocally established, it will enlist public confidence and adequate funds for drainage enterprises may be easily secured. Besides uniformity, simplicity and constitutionality, there must be a just and equitable distribution of expense and benefits. This irrepressible sentiment has led to the movement for the evolution of a broad and comprehensive plan to reclaim the swamp lands, the characteristic features of which are: Its freedom from dilatory restrictions; the legality of its provisions and requirements; its undoubted harmony with the constitutions of the several states.

THE MODEL DRAINAGE LAW. The First National Drainage Congress adopted a resolution requesting the Federal Government to enact laws to reclaim the swamp lands of the nation and insure their development, and for this purpose to create a National Commission to make surveys, estimate costs, and develop a comprehensive plan of national recla-

mation in connection with the several states so designed as to coördinate their mutual interest in a practical State and Federal System of consistent and progressive drainage, reclamation and development. The legislatures of the various states were likewise requested to enact drainage laws forthwith. To insure the passage of uniform, simplified and more effective drainage and levee laws for the various states, the executive officers of the National Drainage Congress called a meeting of all persons interested in this question to meet at Memphis, Tenn., on January 21, 1912. At this conference, the outlines of a model uniform drainage and levee law were formulated and a committee was appointed to complete the work. The bill as finally drafted was reported to the National Drainage Congress at its second meeting held in New Orleans in April, 1912, and approved. One state adopted this measure in a modified form at once and it has since been adopted by some six or eight others.

This model uniform law is based principally on the Missouri statute of 1909 as amended in 1911, the general provisions of the statute being retained and a few important amendments inserted. Probably no state in the Union has done more to develop consistent, scientific, comprehensive and praticable drainage laws than Missouri, and a study of the progress of drainage legislation in that state is inspiring. The results of more than a quarter of a century of intelligent and experimental investigation were expressed in the laws enacted in 1909 and 1911. They have been found adequate both in the organization and administration of levee and drainage districts. Their general provisions have been used as models for the preparation of laws in other states, and the Department of Agriculture at Washington has enthusiastically recommended this system. The constitutionality of these laws has been universally upheld in the numerous opinions handed down by the Supreme Court of Missouri during the last few years, and whenever drainage districts have strictly adhered to the

provisions of these statutes, their action has invariably been sustained. These laws were not without certain blemishes and imperfections, however, and the need existed to effectualize some of the less responsive provisions, to simplify their use and clarify their meaning by employing terse, expressive and perspicuous English. A critical investigation was accordingly undertaken, conducted by a Missouri engineer of recognized standing and national reputation, and the fruits of that admirable survey are now expressed in the Missouri law of 1913, and the model law which is its legitimate offspring.

The sections in this model law are arranged in the order in which the various steps must be taken to organize and administer the affairs of a drainage or levee district. These sections are divided into four groups: Organizational, Administrational, Definitional and Discretional. After enumerating the steps necessary to organize and administer the affairs of a drainage district, the terms, powers, duties and court procedures are given; those sections conferring additional or discretionary powers upon court, landowners or officers are placed last. The language employed is simple and direct, uncertain and ambiguous sentences are wanting, conflicting and contradictory sections are compressed and skillfully articulated, and not more than one separate and distinct subject is dealt with in a section.

Succinctly stated, the model drainage and levee law provides for the organization of drainage and levee associations, for sanitary or agricultural purposes, on petition of the owners of a majority of the lands affected, filed with the appropriate circuit court.

The administrative supervision of the district is entrusted to a Board of Five Supervisors, who are owners of real estate in the district, and who hold office for terms of five years, the term of one supervisor expiring annually, and who are elected by all of the landowners of the district.

The duties of this Board are:—to appoint an engineer to perfect a plan for reclamation; to levy a tax at a level

rate of 25 cents per acre to defray all preliminary expenses; to supervise the construction of all work designed in the plan for reclamation and approved by the court; to levy a tax to defray all costs and to provide for its collection in annual installments; to employ an attorney; to issue bonds or other evidences of indebtedness; to appoint overseers to police the district; to levy a maintenance tax annually; and to provide if necessary or desirable for the progressive consolidation of contiguous districts.

The features of this law which should commend it to the serious and thoughtful consideration of the lawmakers of those states whose laws are ambiguous and unsatisfactory are the following: Its adequacy in the promotion of drainage enterprises; its simplicity and the ease with which the procedure in organization, administration and maintenance may be understood; its undoubted constitutionality; it is just and equitable, affording protection to the small holder against the rapacity of dishonest promoters; it equalizes the costs in proportion to the benefits derived; it is thoroughly democratic, in that the most important part of the work is intrusted to the persons directly interested and who will be taxed for construction, operation and maintenance, and where it continues to reside until the end of the district's corporate existence.

COMPREHENSIVE DRAINAGE SYSTEMS. The process of improving and straightening natural streams and watercourses and constructing supplementary artificial channels is temporarily and locally successful. When districts are enlarged and extended by the incorporation of contiguous territory, the capacity of the existing drains is frequently inadequate, and the area subsequently added is inevitably drained at the expense of the original system. These unfortunate conditions grow progressively more acute. To guard against such disastrous contingencies, each district should be designed as a part of a complete and harmonious system, based upon existing topographic and hydrographic conditions. In this way, the development of independent

drainage units will be rendered feasible, and the main drain and the tributaries will be so adjusted to each other that each succeeding increment of water will be adequately accommodated by a corresponding increase in the cross section of the main stream. The ultimate economic advantage of this procedure is apparent. It follows naturally, then, that all drainage enterprises of any magnitude should invariably be preceded by a thorough, systematic and scientific survey. The preliminary investigation to ascertain the feasibility of a proposed reclamation project will cost from 7½ to 15 cents per acre. The complete survey, including the preparation of maps, profiles and specifications, will not cost to exceed 25 or 30 cents per acre. The complete survey, instituted to ascertain the practicability and economy of a drainage project, should include accurate scientific data on the following subjects: The total drainage area; the maximum annual precipitation; the maximum quantity of water to be disposed of; the climatological conditions and the frequency and severity of floods; the elevations and depressions; the courses and capacity of streams; the location of buildings, roads, bridges, railroads, forest areas and arable and non-arable lands; the probable cost of the work, including clearing, installation of machinery, excavation, deterioration and profit; the comparative cost of large and small drains; the dimensions of proposed drains, including the probable stability of the banks, and allowing generously for the inevitable sloughing, caving and accumulation of talus, with ample berms, and a contemplated clean-out after a lapse of 2 or 3 years when the disturbed earth has become sufficiently compacted. The information thus accumulated will be a permanent and invaluable asset to the community and can be used in perfecting plans of reclamation, estimating costs, assessing benefits, providing for a harmonious and progressive development of complete and integrated systems of drainage and in the construction of roads, bridges, telephone, telegraph and power lines.

This method has already been adopted by five states of

the Union, but only four have used it extensively or successfully.

Missouri. The most colossal drainage project ever undertaken in the United States is in the Little River Drainage District in southeastern Missouri. This district comprises an approximate area of 560,000 acres, and is about equal in size to the state of Rhode Island. It is 90 miles long and its average width is 17 miles. The watershed draining into this district has an area of 1,136 square miles. The topographic expert who prepared the plans is an acknowledged authority in that exacting science. When the plans were completed, they were submitted to several of the most eminent engineers in the United States for inspection and approval. When the drainage system is completed, there will be 700 miles of ditches and levees. The benefits assessed and confirmed by the court amount to $13,500,000, and the total cost will be about $4,500,000.

Texas. The existence of extensive areas of unreclaimed lands in Texas has called for centralized and heroic action. Accordingly, a State Levee and Drainage Commission was created in 1909, consisting of the Governor, the Attorney General and the Commissioner of the General Land Office. Acting on authority conferred by the statute a capable and experienced topographer, connected with the United States Geological Survey, was selected as the first State Levee and Drainage Commissioner. Surveys were immediately instituted through a formal coöperative contract with the United States Geological Survey, by the terms of which the state designated the areas to be mapped, the Federal bureau conducted the investigations, and each paid one-half of the expense. In June, 1910, the coöperative arrangement was discontinued, and since then, the Commission has carried on the work independently or under similar contracts with other institutions as seems most advantageous to the state. Under these arrangements, valuable assistance has been rendered by the Department of Agriculture and the Department of War, and several important and extensive

projects have been successfully undertaken. In the promotion of this work, certain practical tests have been uniformly applied. A preliminary examination is made by the State Levee and Drainage Commissioner to ascertain whether a project is feasible, whether the community has taken the necessary steps to organize a drainage district, whether the organization if perfected appears practicable, and whether there is an immediate necessity for the survey. By this process of judicious elimination, six of the more meritorious districts were selected, and topographic maps have been prepared which represent an area of 101,077 acres. These maps, which are executed with the most painstaking accuracy and fidelity, have cost from 8½ to 10 cents per acre. Since the creation of this Commission, $62.000 have been appropriated out of the public treasury for carrying on the work. From the standpoint of the state, this is an unusually profitable investment. The total cost of reclamation to the state is generally 10 cents per acre, and it never exceeds 20 cents. At the increased valuation, the state is completely reimbursed for its outlay in from two to four years.

Illinois. Extensive drainage investigations have been undertaken in Illinois under the direction of the Internal Improvement Commission and the Rivers and Lakes Commission. The duties of the former as fixed by the statute are to investigate the reclamation of lands subject to overflow or inundation, and to accumulate such statistics as will enable the General Assembly to devise measures for their reclamation. The Rivers and Lakes Commission was created in 1911. It consists of three members, a civil engineer of recognized standing, a lawyer of extensive experience, and one other person intimately acquainted with the rivers and lakes of the state. This Commission is invested with extensive powers, conspicuous among which is the collection of drainage and reclamation data, which is furnished to any applicant at the actual cost of procuring it. Since their organization, these Commissions have coöperated

with the United States Geological Survey and the expenses incurred have been paid at a ratio previously agreed upon. The investigations conducted have furnished valuable data as to the discharge or run-off of twenty-two of the more considerable and incorrigible streams of the state, including the daily and monthly discharge of water, and certain climatological statistics, including the aggregate precipitation, mean annual temperature, wind movements and relative humidity.

The first report submitted by the Rivers and Lakes Commission constitutes an elaborate plan for the reclamation of the overflowed lands of the Kaskaskia valley and one of its most important confluents, embracing an aggregate area of approximately 254 square miles, or 162,000 acres. This comprehensive report exhibits in detail all railroad and highway bridges, all artificial channels communicating with that stream, the maximum and minimum precipitation, the character of the soil, crops and timber, with data on the most destructive floods, and the power of resistance displayed by the existing levees; the quantity of land submerged at various points along the stream, the provisions already made for reclamation, the necessary rapidity of discharge to prevent the filling of the valley, the specifications for levees, and all cut-offs, bluff diversion ditches and sedimentation areas. Having accumulated this information, the Commission perfected a plan by which the whole valley may be reclaimed in such manner as to render possible the development of independent drainage units. Accordingly, the territory was divided into twenty-eight units, numbered from one to twenty-eight, the odd numbers on the right bank and the even numbers on the left, and varying in area from 600 to 15,000 acres. A detailed description, including the character, extent and estimated cost of reclaiming each unit, was then worked out. The total estimated cost of the entire project, including the correction of the main channel of the Kaskaskia and its confluent streams, the erection of levees, the construction of gravity outlets,

and other contingent expenses, was $4,779,000, an average of $35 or $40 per acre; the estimated benefits ranged from 50 to 100%.

A similar study of the Little Wabash and Skillet Fork Rivers was undertaken in 1911. The estimated cost of reclaiming the 128,000 acres on these two streams is $662,000; the estimated benefits which will accrue are $5,100,000, or about 3½ times the entire cost of the work.

New York. The Conservation Department of the state of New York, which was created in 1911, is authorized to exercise extensive powers in the drainage and reclamation of swamp lands, but as yet very little has been undertaken in this direction, except to procure an important decision from the Supreme Court of Appeals relative to drainage affecting the public welfare.

Minnesota. The only state, with the possible exception of Texas, which has established a real, efficient drainage commission, is Minnesota. This commission consists of the Governor, the Secretary and Auditor of State, but in reality, its functions are delegated to an engineer, whom they appoint, and who is authorized to exercise extensive powers throughout the commonwealth. Aside from the construction of state drains for the redemption of state and private lands, they are required to make a comprehensive topographical survey of the state, to furnish accurate scientific data to any county applying for such information, and no county may undertake a reclamation enterprise until the plans are approved by the state Drainage Commission. This insures uniformity in all reclamation enterprises and is a guarantee that all drainage districts as they are successively created will supplement each other and form parts of an adequate, unified, mutually consistent and comprehensive system.

Wisconsin. Hereafter all plans for the reclamation of overflowed lands in Wisconsin will be inspected and approved by the college of agriculture of the State University.

AGENCIES WHICH ARE INTERESTED IN THE PROMOTION OF DRAINAGE. The agencies which have been chiefly instrumental in the promotion of drainage and reclamation enterprises are The National Drainage Congress, The Southern Commercial Congress, The Missouri Levee and Drainage Association, The Indiana State Board of Agriculture, and various other equally notable and active organizations throughout the country. The appalling flood which devastated the Ohio valley in 1913 aroused these organizations to a more vigorous and persistent activity. In a dispatch to the Chairman of the Executive Committee of the National Drainage Congress on March 27th, 1913, President Wilson said:—"The calamity in Ohio and Indiana makes clearer than ever before the imperative and immediate necessity for a comprehensive and systematic plan for drainage and flood control." In response, Mr. Edmund T. Perkins said:—"Knowing that such catastrophes are needless," the National Drainage Congress accepts the responsibility of "presenting to the people and the Congress of the United States a plan to alleviate and prevent the recurrence of loss of life and property."

The National Drainage Congress. An association known as the National Irrigation Congress has been in existence for 20 years. The chief interest of this organization is in the reclamation of waste and arid lands by irrigation. When its nineteenth annual meeting was held in Chicago in 1911, a strong sentiment in favor of land drainage manifested itself, and the need for a nation-wide movement, mutual agreement and concerted action to achieve tangible results, led to the organization on Dec. 7, 1911, of the National Drainage Congress, a separate and independent institution, designed to promote the reclamation of lands by drainage. The objects of this Congress as set forth in the constitution are to diffuse knowledge concerning the reclamation of lands, to promote navigation by means of canals built for drainage purposes and the streams into which they discharge their waters, to conserve and impound water for

drainage and flood protection, to conserve and control natural resources pertaining to agriculture, to restore and preserve soils by the overflow of silt, to remove the menace to the public health constituted by undrained lands, to facilitate conferences and deliberations concerning drainage, and to provide means for bringing the needs of the people to the attention of the state and federal governments.

The Southern Commercial Congress. Among the newer organizations, none is more active, influential and public-spirited than the Southern Commercial Congress, a vigorous and thrifty organization now in its fifth year. This Congress is divided into sections, one of which devotes its exclusive attention to drainage. At its Fourth Annual Convention held in Nashville, Tenn., in 1912, resolutions were adopted designed to inaugurate an educational campaign to demonstrate to the people of the United States and to the owners of swamp and overflowed lands in particular the economic value of reclaiming these lands and making them fit for cultivation; to provide for the appointment of a Commission to simplify and standardize the drainage laws of the several states and secure their adoption by the several state legislatures; to petition Congress to institute a complete survey of all swamp and overflowed lands in the United States and to work out a comprehensive plan for drainage and conduct an examination of the soils and their adaptability to the growth of profitable crops; and to solicit the co-operation of all commercial organizations, railroads, banks, and business interests in carrying out this plan.

The agencies which were chiefly instrumental in the promotion of drainage in this state are the State Board of Agriculture, certain enterprising and public-spirited citizens, drainage associations, the organized association of tile makers, actuated largely by economic motives, physicians and others interested in the improvement of the public health, and the state itself. The activity of the State Board of Agriculture was commendable and noteworthy. Beginning with 1851 they offered a premium at the state fair for

the best essay on the subject of drainage, and during the same year they sent out a list of questions to ascertain the condition of agriculture in this state, one of which related to the improvement of wet lands and the best and most economical methods employed in ditching and draining.

FEDERAL AID TO DRAINAGE. In 1850, Congress passed a law commonly known as the "swamp-land grant" which became effective on Sept. 28th of that year. By the provisions of that act all swamp and overflowed lands were granted to the several states in which they were located. The proceeds from the sale of these lands were applied exclusively, so far as necessary, to their reclamation by levees and drains. The intention of the act was to place the burden of draining on the lands themselves and not on the states or the Federal Government. In every state except Florida these lands speedily passed to private ownership; that state still retains 1,400,000 acres of the original grant, known as the Everglades, and is now actively engaged in reclaiming them This condition of diversified and widely distributed ownership is one of the serious difficulties to be overcome. During the last four years, bills have been introduced in Congress designed to secure Federal aid in the reclamation of these lands and the plan proposed is similar to that under which the Federal Government now reclaims the arid lands of the western states by irrigation. The theory is that "if the Federal Government has power to put water on the arid lands of the West, it has the same power to take the water off of the wet lands of the East." It should be noted, however, that the Federal reclamation act was passed primarily to reclaim the extensive area of arid public lands in the west and not for the reclamation of private property Since the swamp lands have long since passed to private ownership, a plan must be devised which originates with the people; private property may not be taken except for public use and then only by due process of law. Obviously neither state nor nation can enforce the drainage of these lands except under the police powers of

the state to abate a public nuisance and safeguard the public health. But although the Federal Government has no power to compel owners to drain their swamp lands, yet it undoubtedly has the power to make surveys of these lands, to determine the approximate cost of reclamation, to develop an efficient and harmonious plan for the various projects as part of a complete system, to analyze the soil and ascertain its probable value when drained and where practicable or necessary to perfect plans for water transportation. Such a bill has been prepared by the National Drainage Congress and is now pending. This bill provides that all revenue derived from the sale of public lands in Alabama, Arkansas, Florida, Illinois, Indiana, Iowa, Louisiana, Michigan, Minnesota, Mississippi, Missouri, Ohio, Wisconsin, and Alaska, beginning with 1901, including certain fees and commissions and excepting the 5% of such sales set aside for educational and other purposes, shall be appropriated as a Flood Protection and Drainage Fund, to be used under the direction of the Secretary of the Interior in the examination and survey for and the construction, operation and maintenance of drains, levees, tree planting and other works whenever needed for the prevention of floods, or the protection, drainage or reclamation of overflowed and swamp lands.

The Secretary of the Interior is authorized to make surveys and examinations, to locate and construct drainage works and to report to Congress annually the estimated cost of contemplated works, the practicability thereof, the quantity and location of such lands, the cost of works constructed or in process of construction and to withdraw any public lands from entry until they are reclaimed. When the Secretary of the Interior decides that any project is feasible, he may let the contract for the necessary works, provided sufficient funds have accrued. When the lands selected for reclamation have passed to private ownership, or when the surveys have been made and plans outlined for their reclamation, the Secretary of the Interior may grant

the privilege to the owners to proceed with the drainage as a drainage district under the laws of the state in which they are located. If the reclamation of any tract of land selected is partly completed, the enterprise may be carried on by the Secretary of the Interior. If the tract selected is contiguous to state or private lands, such tracts may be combined in one district. Ownership of all works constructed is to reside in the government until all assessments are paid. If the contemplated drains when constructed will be large enough for navigation, the Secretary of the Interior may, with the consent of the states or the owners, refer the plans to the Secretary of War for examination by the Chief Engineer of the United States army as to their practicability for navigation waterways. If the Engineer approves of the plan a joint report will be made to Congress by the Secretary of War and the Secretary of the Interior, and if money is appropriated the two secretaries agree on a mutual plan of improvement. The system when completed will be subject to the same control as other navigable waterways. Interstate drains are similarly provided for, and the bill carries an appropriation of $20,000,000.

STATE AID TO DRAINAGE. The question of direct state aid and centralized supervision of drainage has already assumed respectable proportions in several commonwealths, and circumstances and conditions in this state amply justify the exercise of some form of centralized authority to promote vigorously and systematically the redemption of unreclaimed and non-arable swamp lands and to prevent effectually the lapsing of those convalescent or fully reclaimed. The commission or other authority intrusted with this important work should be required to perform other additional ancillary public functions, such as the supervision of all navigable and non-navigable rivers and lakes of the state, the conservation of water power, the adoption of measures to reasonably safe-guard the citizens of the state against such costly and destructive calamities as that by which they were prostrated during the past year, the making of sur-

veys and the collection of data on natural resources, the prevention of encroachments on lake and river fronts or the pollution of streams and the ultimate establishment and control of public recreational parks. A wise and judicious consolidation of existing departments, and the utilization of the services of scientific experts already in the employ of the state, would render the creation of new offices unnecessary, and the results of their united efforts would abundantly repay the state for the meagre and inconsiderable outlay.

The agitation for the exercise and extension of the paternalistic powers of the state in this laudable and much neglected enterprise has expressed itself in two distinct but mutually consistent programs. The former calls for a vigorous centralized supervision of state conservation and reclamation, a plan which has already been successfully undertaken by Illinois, Minnesota, New York and Texas. The latter seeks to secure direct state aid in the correction of incorrigible and meandering watercourses and to provide subsidies, under proper restrictions, for enterprises of undoubted, imperative and meritorious validity. The state of Illinois definitely committed herself to this policy in 1913 by the appropriation of $339,000 to construct, repair and maintain the levees along the Mississippi and Ohio rivers which were demolished by the unparalleled floods of last year. Her action in this matter was inspired alike by necessity, economy and public policy. The tax levies of the cities to which this appropriation was made had already approached and exceeded the constitutional limitation; during 1912 and 1913 the state had already expended $160,000 in the protection of life and property in these exposed localities; while a wise and enlightened public policy renders the expenditure of money for such purposes an enviable and unique distinction. The sum of $3,000 was likewise appropriated to the village of Naples, on condition that a like sum be raised by that corporation. This money is to be expended under the supervision and direction of the Rivers

and Lakes Commission and with the consent and approval of the Governor.

Aside from such imperative and obvious contingencies, competent and practical engineers, who have had extensive experience in this work, are inclined to the opinion that if state subsidies are granted, they should not only be rigorously supervised but should be confined exclusively to the improvement of the channels of watercourses, the removal of obstructions and debris, and the construction of cut-offs and should be administered and expended in the same manner in which Federal aid is now disbursed for the correction of navigable streams. Such assistance would not only impart a much needed stimulus to this important work by conquering the shiftless indifference of many landowners, but the value which would be added to real property would abundantly repay the state in taxes in a very few years.

A somewhat different form of state aid is that by which provision is made for small loans out of the public treasury. This system was instituted in England in 1829 under certain necessary restrictions, and was adopted by Maryland in 1912. By the provisions of the Maryland act, $10,000 was appropriated out of the state treasury to assist impecunious drainage districts in the prosecution of reclamation enterprises, not more than $2,000 of which may be appropriated for any single undertaking.

The record of the state of Indiana in such enterprises is far from enviable. On three separate and distinct occasions, money and services have been contributed to preserve state property from threatened impairment by the badly drained lands contiguous to the tracts on which public buildings were located. In 1837, the services of the State Engineer and his assistants were contributed to prevent the encroachment of floods on the state house grounds from the unreclaimed flood-plains of Fall Creek, now comprised within the corporate limits of the city of Indianapolis. In 1885, $500 was appropriated out of the state treasury to drain the grounds of the House of Refuge at

Plainfield, and in 1873, and again in 1883 provision was made for the drainage of the tract of the Prison North. In two instances, state officers have been authorized to exercise supervisory and inquisitorial powers over incorporated drainage associations. To prevent the practice of irregularities under the act of 1871, and to insure an honest and judicious expenditure of revenue and to guarantee publicity of all financial transactions, the governor was required to approve each and every issue of bonds; quarterly reports were made to the Auditor of State, and that officer was further required to institute an inspection of the company's books whenever a reasonable presumption of guilt existed. The trustees of the sanitary district in Lake county created by an act of the General Assembly of 1913 are required to make separate annual reports to the Governor and the two branches of the Legislature to insure a faithful, economical and judicious dispensation of the company's affairs.

State Aid in Indiana. The most notable and conspicuous examples of state aid and state supervision were those which attended the efforts of this commonwealth to reclaim the waste lands in the region of the Kankakee and Calumet rivers, and the Federal Swamp Lands granted to this state by virtue of an act of the General Government of 1850. Untold benefit has accrued to the people of this state by these three projects but their complete success has been seriously frustrated and perverted for reasons which will appear in the sequel.

The Kankakee Region. The agitation for the reclamation of the Kankakee swamp began as early as 1850. Persistent and ill-advised procrastination, however, delayed action in this important undertaking until 1881. Over $70,000 have been appropriated out of the state treasury to defray the cost of this project. This money has been employed in the examination and survey of contemplated drains, and for the removal of the Limestone Ledge, an ob-

struction a mile and a half in length and more than three hundred feet in width which impounded the water and constituted, together with the innumerable beaver dams, an insuperable obstacle to effective drainage. The work was supervised by commissioners and engineers appointed directly or indirectly by the governor. With the removal of these barriers the river flowed tortuous but unvexed to the state line, and artificial drainage proceeded with considerable rapidity. Even as late as 1911, however, an important obstruction existed in the river on the Illinois side, and a resolution of that year invoked federal aid and the cooperation of the state of Illinois in its removal.

The Calumet Region. In 1881, $6,000, to be expended under the joint supervision of the board of county commissioners of Lake county and the governor, was appropriated to remove a delta or sand bar from the Calumet river, at the mouth of the Hart or Cady state ditch, which had been accumulating for some years, and had finally assumed such dimensions as to seriously obstruct the river.

Federal Swamp Lands. The results attending the attempts to drain the Federal Swamp Lands were in many cases distinctly disappointing. By virtue of the federal swamp land act of 1850, the state came into possession of 1,378,000 acres of unreclaimed lands, for the redemption of which a sum aggregating $1,297,000 was expended. The legislation designed to promote this notable undertaking covers a period of 56 years, and at least 34 laws and 6 resolutions were adopted to provide for their sale and reclamation, and for the adjustment of claims and the perfection of titles. These lands were placed on the market in 1851 at $1.25 per acre, and fifteen months later, on May 29, 1852, and after an investigation had been made, a method of reclaiming them, which applied to seventy-one counties, was adopted. A swamp land commissioner was appointed by the governor in each county, who with the assistance of a competent engineer examined and surveyed

the swamp lands and ascertained the cheapest and most expeditious method of drainage.

The results on the whole were rather unsatisfactory, and many counties complained that they had derived little or no benefit from the undertaking. Moreover, the opportunity for fraud in the sale of contracts and the practice of paying contractors for their work in land was too frequently taken advantage of, while the scandalous and disgraceful adventures of several prominent public officials in the misappropriation of public funds, renders this one of the most sordid and uninspiring chapters in our history.

DRAINAGE QUESTIONS PECULIAR TO INDIANA.

REDEEMING THE STATE. One of the most commonplace and unromantic, but certainly the most beneficial and far-reaching public enterprise ever undertaken by the citizens of this state has been the redemption and reclamation of the non-arable swamp lands. This enterprise has been carried on with unequal vigor for a period of one hundred and fifteen years, and there is tolerably authentic evidence that numerous unrecorded efforts were made even much earlier. These chronicled and unchronicled undertakings representing the tenacious and cherished ambitions of fully one hundred and twenty-five years, are recorded in two hundred and seven distinct laws and resolutions, and illustrated by the fragmetary and fugitive scraps of contemporary literature in which the annals of our history is preserved. Since the organization of political institutions in this state, at least one thousand drainage measures of varying and unequal degrees of merit have been seriously considered by our lawmakers, and months of time have been consumed in advocating their adoption or securing their defeat. Swarming with ambiguous, pernicious, impracticable, confiscatory and non-workable provisions as even the best intentioned and most skillfully framed statutes too frequently do, scores of judges throughout the commonwealth have bestowed their maturest thought to the vexing task of elucidating and interpretating these statutes, and a host of lawyers have found this one of their most lucrative and unfailing sources of revenue. The drainage achievements to date, representing the cumulative industry of fully five generations of men constitute a gigantic arterial system of subterranean and surface conduits, aggregating 320,000 miles in length, which ramifies and tesselates the whole extensive area of the physical commonwealth. This stupendous capillary system speedily conducts the superfluous accumulations of water from 17,000,000 acres of productive

farms where it has been deposited by showers or left by melting snow. It has added untold millions to the wealth and prosperity of the state, improved the public health to an almost incredible degree, involved the annual expenditure of hundreds of thousands of dollars in its maintenance and augmentation, and afforded honorable, remunerative and profitable employment to an army of laborers, enterprising contractors, thrifty manufacturers and promoters.

NATURAL DRAINAGE AND PHYSIOGRAPHIC CONDITIONS. The state of Indiana comprises an approximate land area of 23,069,000 acres. The natural drainage systems are fairly adequate. The northern three-fifths of the state is heavily glaciated, and is drained into the St. Lawrence by means of the Calumet, the St. Joseph and the Maumee rivers and into the Mississippi by means of the Wabash, the Kankakee, the Illinois and their innumerable tributaries. When the territory was first visited by civilized men, the eastern half of this glaciated area consisted of spacious treeless meadows, some well watered, others dry and arid, supporting wild grass and wild hemp, alternating with deep woods, the open prairies predominating in about the ratio of three to one. The extreme northeastern part of the state is studded with some 2,000 small lakes and kettleholes, fashioned during the glacial epoch, and preserved by the peculiar disposition and arrangement of the lateral and terminal moraines. The western half, between the Wabash and Lake Michigan, is a succession of woodlands, prairies, lakes and swamps. The savannas of this region are of two kinds: Untimbered alluvial flats, and upland prairies, rising to an altitude of 50 to 150 feet above the neighboring bottoms, and presenting an undulating and ridgy surface. The soil of both is of inexhaustible fertility.

The southern two-fifths of the state is non-glaciated and is more predominately rugged and hilly. It is drained exclusively into the Mississippi by means of the Ohio and the Wabash and their confluent streams. During the pioneer period, the country along the Wabash and its tribu-

taries was a succession of swamps, morasses, and beaver ponds, indescribably rich, alternating with high ground and small savannas, badly watered. These swamps or wet prairies consist of spongy, alluvial deposits, superimposed on a stratum of unporous clay. They are from four to six miles in width traversed by countless small sluggish streams and were subject to destructive periodical inundations which frequently extended for a distance of six or seven miles from the river and rose to a height of ten feet. By the accumulation of settling alluvium, these periodical inundations enhanced the fertility of the bottom lands, rendered them increasingly valuable possessions, and induced the settlers, in spite of the inevitable hazard involved, to fix their habitations in close propinquity to the main stream. The peril to which an unexpected rise of the river exposed them, stimulated the earliest recorded enterprises to deepen and straighten the more inconsiderable watercourses, and to erect artificial obstructions along the banks of the main streams, a species of activity which has continued to be the predominant drainage characteristic in this portion of the state for over a century, and is still pursued with unabated vigor.

Development of Artificial Drainage. In drainage, as in all other forms of industry, there has been a progressive development from individualism, the predominant characteristic of the eighteenth century, to the collective cooperation and paternalism of the nineteenth and twentieth centuries. The earliest recorded efforts to reclaim submerged or non-arable lands were promoted by individual land owners, each pioneer redeeming a few precarious acres by the erection of feeble barriers against the encroachments of floods, or conducting the stagnant and unwholesome water from his land by the construction of shallow artificial channels. This method was inadequate, laborious, expensive or even prohibitive where an outlet had to be obtained across the land of obstinate, selfish, unfriendly or recalcitrant owners. This insuperable obstacle made cooperation

desirable or imperative, and communistic action promptly succeeded. These gregarious enterprises were originally confined to the more favored, fertile, and thickly populated localities of the state, possessing mutual and unconflicting interests. The area which they were designed to redeem rarely exceeded a few hundred acres in extent, and their success depended on the voluntary and mutual consent of all interested owners. Beginning with one farm, or at most a few contiguous farms, which could be successfully and advantageously drained by the construction of a single system disemboguing into a convenient and uncontested outlet, the next step was to extend the application of the law to a territory co-terminus with an entire county. Within the county, naturally, several distinct and unconnected systems would be established, but its operation was uniform throughout the designated territory. The first state-wide drainage act was passed in 1852 after the adoption of the new instrument of government during the preceding year had rendered special legislation unconstitutional and invalid. Provision has subsequently been made for the construction and maintenance of inter-county and inter-state ditches, drains and levees. These state-wide drainage acts have been repeatedly and wisely differentiated to meet the needs of the various parts of the state both rural and urban and finally in one notable and in several unimportant instances, the commonwealth has exercised supervision and extended direct state aid to the promotion of drainage enterprises.

One of the expensive and inevitable blunders committed by early drainage promoters was the construction of drains of insufficient magnitude to adequately perform their functions In 1851, Governor Wright expressed it as his matured conviction that drains two feet deep and two feet in width were of sufficient capacity to redeem most of the unreclaimed swamp lands, and the ditches of that period and even as late as 1870 were seldom larger. Gradually the necessity for larger drains became imperative and ditches four, six and ten feet in depth were not uncommon.

METHODS EMPLOYED IN DRAINAGE. Four methods of drainage have been successfully and continuously employed in this state: (1) Open ditches; (2) Subterranean, underground or blind ditches; (3) Dams, embankments, or levees, in connection with which accessory pumping plants and sluice-ways have frequently been installed; and (4) The utilization of natural streams and water courses, by straightening, widening, deepening and removing obstructions from their channels.

Open Ditches. The method of draining land by open, sloping, hand-dug ditches was introduced in this state as early as 1799, but such drains were not constructed extensively or systematically by mutual cooperation prior to 1835. Such ditches were usually constructed twice as wide at the top as at the bottom, and from two to six feet in depth. When the ground was loose and friable, or consisted of gravel, alluvium or muck deposits, the work was done exclusively by hand; where the earth was more compact, plows were used to loosen the soil, and it was then thrown out with shovels. The introduction of the floating steam dredge has rendered this form of hardy enterprise less arduous, materially reduced the cost, and rapidly promoted the redemption of the non-arable lands. Open drains are constructed at the rate of about 1,500 miles per year. Prior to 1884, few counties in the state had over 1,000 miles each. There are probably 75,000 miles of open drains in operation in this state at the present time.

The Ridge and Furrow Method. The ridge and furrow method of drainage has been used extensively in all parts of the state, and is still widely employed. When there is sufficient fall, the land is plowed in beds or ridges, from 15 to 30 feet in width, divided by furrows or trenches 20 inches wide and 18 inches deep, run in parallel lines and at a slight angle to the plane of inclination of the ground. The excess surface water drains off quickly through these furrows.

The Shaft Method. The so-called shaft method is sometimes employed in impervious clay soils. Shallow ditches are dug, and the bottoms pierced at appropriated intervals, through which the water easily escapes to the porous substratum.

Subterranean, Underground or Blind Ditches. The method of draining lands by the construction of subterranean or underground drains, was introduced in this state about 1841. Underground drains are preferable to open drains because the trench can be filled in and farmed over. Of all types of subterranean conduits, the tile drain is deservedly the most popular because of its convenience, durability, efficiency and economy. Before tile were invented and manufactured, however, several varieties of underground drains were extensively and successfully employed.

(1) *Brush Drains.* The brush drain was probably the cheapest form of underground drain ever devised, but not very durable. A trench of proper dimensions was dug and then filled with brush to a depth of 18 inches and the earth replaced. This form of drain was used extensively from 1853-1860 and even much earlier.

(2) *Stone Ditches.* Drains constructed with stone have been widely employed in many parts of the state. Trenches were dug from 6 to 24 inches in width at the bottom and from 2 to 6 feet in depth, depending on the nature of the soil, being shallow in clay soils and deep in black or alluvial deposits. These ditches were then curbed on the sides with cobble stones, four or five inches in diameter, laid up loosely without mortar and surmounted by large flat stones, laid across the top to enclose the channel thus formed. Sometimes two layers of cobble stones were used. The channel or duct when completed and enclosed was from 4 to 10 inches in width and from 6 to 15 inches in depth. The dirt was then replaced. Sometimes cobble or broken stone were thrown into the trench, without order to a depth of several inches, covered with brush or straw to exclude the debris, and then filled in with dirt. In some

cases the wall of the ditch was cut with a shoulder of earth and flat stones laid thereon. These ditches were very economical and satisfactory where limestone, sandstone, or slate abounded. They cost from 20 to 50 cents per rod, depending on the accessibility of stone. They were used extensively during the decade preceding 1860 and only went out of use when tile became cheap and abundant. Where stone was not plentiful or available, brick or even sod were used. The cost of brick curbed ditches in 1860 was about twenty-eight cents per rod.

(3) *Timber Ditches.* Trenches for timber drains were dug from 18 to 30 inches deep, and from 16 to 30 inches wide. Oak slabs, strips or puncheons, either split or round, were then prepared, from 14 to 30 inches long, 1 1-2 to 3 inches thick, and as wide as the tree or sapling from which they were split. These slabs were then placed in the trench and leaned obliquely in such manner that one end was set firmly against the bottom at one side with the top resting against the opposite side, and reaching within 8 or 10 inches of the surface, and below the ordinary depth of plowing in such manner as not to interfere with cultivation. The dirt was then replaced, leaving a triangular shaped channel through which the water readily escaped. Sometimes a trench was constructed 30 inches wide and 20 inches deep, in the bottom of which a channel was cut, 12 inches wide and 12 inches deep, leaving a shoulder 9 inches wide on either side, on which planks were placed. Another method was to cut a notch or groove in either side of the trench, 12 inches from the bottom, insert cross pieces of proper lengths, and place saplings 4 to 10 inches in diameter thereon, lengthwise of the ditch. Long rectangular boxes constructed of plank were frequently used. Drains constructed of wood lasted about 10 or 12 years and cost from 16 to 75 cents per rod. An experiment treating chestnut boards with vapor of carbolic acid to preserve them from decay was made in 1869. The success of this experiment seemed to demonstrate temporarily that

timber for drainage purposes was preferable to and cheaper than brick tile. From 1850-1865, and while timber was still abundant, many timber drains were constructed, but as they fell into disuse, they were gradually superseded by tile drains.

(4) *Ditching Machines.* Ditching machines have been used in this state with indifferent success since 1840. The sub-soil or mole-plow achieved the widest popularity. The mole-plow was a machine so constructed as to lift the soil, and produce a duct or passage for water from 12 to 36 inches underground. From four to six yoke of oxen and a capstan were required to draw it, and from 60 to 100 rods of ditch could be completed in a day, at a cost of 16 to 25 cents per rod. The mole-plow was used extensively in some parts of the state from 1850-1860.

(5) *Tile Drainage.* The first experiments with tile drainage in the United States were made on the borders of Seneca Lake, near Geneva, New York. This fact and the beneficial results attending the experiment were widely proclaimed by the agricultural papers of the country, and farmers in other states tried it. The first machine for the manufacture of drain tile from clay was introduced into this country by Professor Norton of Yale, and similar machines were introduced into this state about 1850. A tile machine was operated at Fort Wayne during 1853, and about the same time a factory was established in Johnson county and another in Franklin county. At first these machines were operated by hand, later by horse power, and finally by steam.

The first tile placed on the market were the so-called horseshoe tile bent into a little less than a half circle, resembling a horseshoe, with open bottoms, drawn out to a distance of 3 or 4 inches on each side, sufficient to form a flat surface to rest on. These tile invariably sank and became disarranged. To insure stability, plates one inch thick and eight or ten inches wide, called soles, were used to lay them on, and finally the sole was attached to and

made an integral part of the tile. Such tile with wide, flaring bottoms were objectionable because the stream of water which flowed through them was spread out so wide and rendered so sluggish that it did not flush out the increasing accumulations of silt. Sole tile with round cavities were next used, and finally the sole was discarded and round or pipe tile were used exclusively. Collars were at first used with round tile to effect a more perfect articulation of the joints. It was soon discovered that these collars obstructed the free access of the water and they were soon discontinued.

From 1850-1860 brick tile were expensive and infrequently used. They won their way slowly through a period of skeptical experimentation to popularity, and by 1865 they had become an established and indispensable institution. Gradually as the old wood and stone drains fell into disrepair, they were replaced by tile drains, but public sentiment yielded so reluctantly to the innovation, that they had not achieved a complete, state-wide triumph until 1890. From 1860-1880, the tile used were very small and much of the work had to be done over.

There were 31,000 miles of drain tile in operation in this state in 1882; in 1895 the last year for which statistics are available, there were 134,593 miles. The average annual increase has been approximately 6,500 miles. If the progress of this industry has gone on since 1895 with the same portentous rapidity, there are not far from 245,000 miles of drain tile in operation at the present time.

One evidence of the growth and multiplication of tile drains was the enormous increase in the number and output of the tile factories. In 1860, there were 20 tile factories in the state and during the ten years from 1860-1870, 58 new ones were established. By 1880, the demand for tile had greatly exceeded the supply and factories were being established rapidly in every county in the state, and tile makers were becoming more active and diligent in the promotion of their industry. Beginning with 1876, they

held semi-annual meetings at Indianapolis. There were 297 drain tile establishments in the state in 1879 and 545 in 1885, the last year for which statistics are available. The value of the drain tile manufactured during this same period aggregated $6,300,000, over 2,000 men were employed and the yearly wage approximated $500,000.

Levees, Dams and Embankments. The lands contiguous to streams and watercourses are reclaimed by the erection of artificial obstructions known as dams, levees, or embankments. The first levees constructed in this state in the vicinity of Vincennes were composed of yellow sand and did not exceed three feet in height. The work is usually carried on by levee associations.

The Utilization of Natural Streams and Water-courses The utilization of natural streams and water courses has been a favorite method of drainage from the beginning. When the natural channel is deepened, widened and straightened the value of the stream is increased many fold.

Ditch Taxes Imposed. The revenue raised by taxation for the promotion of drainage is but a tithe of that contributed by individuals to whom the benefits directly accrue. However, during the twenty-two years from 1889-1911, inclusive, the several counties of the state expended as their respective shares of drainage projects the sum of $2,400,000. In some counties a tax, appropriately designated, is regularly imposed to create a ditch fund. In 1911, such a tax was collected in twelve townships in Spencer, St. Joseph, Wabash, Wayne and Whitley counties, and since 1907 the revenue which has been covered into the treasuries of these counties from this source aggregates $332,000.

Classification of Drainage Acts. For convenience, the drainage acts and resolutions of the territorial and commonwealth periods may be grouped into four distinct classes: (1) The highway drainage acts, passed between 1799 and 1883; (2) The special drainage acts passed between 1799 and 1852; (3) The state-wide drainage acts

passed between 1852 and 1913; and (4) The acts designed to extend direct state aid or exercise administrative supervision, including the sale and redemption of Swamp Lands, the removal of obstructions from the Kankakee and the Calumet rivers, and the improvement of the tracts of the Prison North and the House of Refuge.

A PUBLIC ENTERPRISE INVOLVING INCIDENTAL DRAINAGE. The natural drainage systems of the state performed their functions inadequately. No artificial drainage had been undertaken except such as was promoted by private enterprise. The public highways of the state prior to 1800, and even much later, were abominable, and rarely passable for vehicles until the beginning of summer. Of the five paramount motives advanced for undertaking drainage, that one which had for its acknowledged object the improvement and preservation of the public roads and highways manifested itself the earliest. The Territorial Legislature devoted considerable attention to this subject, and the work was taken up and vigorously promoted by the General Assemblies of the Commonwealth. Twelve highway laws providing for incidental drainage were passed, covering a period of eighty-four years, from 1790 to 1883, inclusive. By the provisions of these acts, road supervisors or road masters were authorized, under the direction of the Court of General Quarter Sessions of the Peace, the Court of Common Pleas, or the several Boards of County Commissioners, to construct and maintain ditches or drains on the lands lying adjacent to the roads intrusted to their charge and of sufficient capacity to preserve such highways from disintegration. Although the paramount motive for constructing these drains was to expedite and facilitate the construction of roads and preserve them from destruction when completed and only incidentally to convey stagnant and subterranean water from the contiguous territory, it can scarcely be doubted that hundreds of acres throughout the state were reclaimed and rendered arable, and that the outlet afforded to private drains, so constructed as to dis-

charge their water therein, has been of incalculable benefit to the citizens of this commonwealth.

THE SPECIAL DRAINAGE ACTS PASSED BETWEEN 1799 AND 1852. Every drainage project undertaken prior to 1852 was authorized and promoted by special legislation. During a period of 53 years, beginning with 1799, 38 acts and resolutions were passed, designed to provide for the drainage and reclamation of eighteen counties and thirteen small and widely separated areas.

1. The small and isolated areas whose drainage was provided for. The thirteen small and isolated districts whose drainage was provided for included Lower and Cathrenettes Prairies, located near Vincennes, in Knox county; Lost Creek in Vigo county; the low lands lying immediately northeast of the city of Indianapolis; the low lands near Center Lake in Steuben county; Round Pond in Eel River, Clay county; Blue River in Shelby county; Shaker Prairie in Knox and Sullivan counties; Jordon Creek in Honey Creek township, Vigo county; Turtle Creek in Sullivan county; the Wabash River in Honey Creek and Prairie townships, Vigo county; Peru and Upper Peru Prairies in Miami county; the town of Cannelton in Perry county; and finally one, Reason W. Prather, was authorized to construct a ditch across a state road in Bartholomew county.

(a) *Reclamation of Lower and Cathrenettes Prairies, Knox County.* If we except the drainage achieved by the construction of ditches designed to enhance and improve the quality of public roads and highways, the first real reclamation enterprise was undertaken in 1807, somewhat more than eight years after the first road law was passed and fully nine years before Indiana was admitted to the Union. By the mutual cooperation of the owners, proprietors, and inhabitants of a portion of Lower Prairie, Knox county, comprehended within an accurately described periphery, an inconsiderable alluvial flat, not above a few hundred acres in extent, situated below Vincennes, contiguous to the Wabash river, and subject to periodical inun-

dations, was reclaimed and protected from submersion by the erection of an artificial obstruction of sufficient magnitude to effectually restrain the waters of that stream. This obstruction was a levee, dyke or embankment composed of earth, stones and yellow sand, eight feet wide at the base, two feet high on a level and six feet wide on top, situated as near the brink of the high bank of the Wabash as appeared necessary and convenient, and extending from the boundary of the town lot of the heirs of Chapard, along the meanders of the Wabash, to the boundary line of Bray's land, and from thence over the most advantageous ground to the nearest highland at the southern bend of the Grand Caulee. From this rather obscure geographical terminology, it is difficult to determine either the length of the dyke or the extent of the riparian lands reclaimed by this primitive and inconspicuous drainage enterprise. The location of this dyke remained unchanged for a period of more than forty years, except for two rather important extensions of the embankment. Its significance lies in the fact that it was the first of a long series of enterprises designed to promote the reclamation of the state.

(b) *Lost Creek, Vigo County.* Lost Creek, an unimportant tributary of the Wabash, enters Fort Harrison Prairie about four miles northeast of Terre Haute. During freshets and periods of unusual precipitation, it overflowed its banks and spread over a scope of territory many miles in extent, producing sickness and destroying property. On January 21, 1837, a complete survey of Lost Creek and the adjacent territory was authorized. Embankments of sufficient height to confine the stream to its channel were erected, and a dam, calculated to regulate the discharge of water, was constructed.

(c) *State House Square, Indianapolis.* In 1837 the overflow from the swamps and low lands lying immediately northeast of the city of Indianapolis encroached on the State house square on the west, north and northeast sides. An act of Feb. 4, 1837, authorized the redemption of these

lands and the cost was defrayed by subscriptions or voluntary contributions.

(d) *Center Lake, Steuben County.* On Feb. 17, 1838, Thomas Gale and others were authorized to drain the low lands around Center Lake, northwest of Angola, in Steuben county, by lowering the lake.

(e) *Round Pond, Clay County.* Round Pond was an inconsiderable artificial body of water formed above the feeder dam on Eel river in Clay county. The outlet of this stream had become seriously obstructed by the accumulation of trees, timber and debris. Valuable agricultural lands were submerged, and the presence of a stagnant pool of water contributed to the unwholesome condition of the neighborhood. By an act of Feb. 8, 1841, the formation of a drainage association was authorized, designed to locate and construct a ditch on the most economical and advantageous route and in such manner as to empty the waters of Round Pond into Eel River far enough below the feeder dam as not to interfere with the water power or the erection of machinery for its free and unobstructed use. The cost of the enterprise was defrayed by voluntary subscriptions.

(f) *Leveeing Blue River, Shelby County.* A faulty and unsatisfactory statute, not sufficiently explicit to outline a definite line of procedure, was passed on January 10, 1845, to provide for the leveeing of either side of Blue River in Shelby county, to protect the agricultural interests of the territory affected.

(g) *Shaker Prairie, Knox and Sullivan Counties.* Several voluntary and extra legal efforts had been made to reclaim Shaker Prairie in Knox and Sullivan counties. A contract had been entered into between the citizens of Shaker Prairie and one, Solomon Wolfe, to carry out this project. Symptoms of disaffection and incoherence in the organization resulted in the inability to enforce contracts and compel the payment of benefits and eventuated in the passage of a law placing the enterprise on a more substan-

tial foundation. This act, which was passed on January 14, 1846, provided for the construction of embankments or levees along the Wabash river where it traverses Shaker Prairie, between two designated points, and at the joint expense of the owners of the land in the Prairie, in proportion to their respective benefits. The work already accomplished was accepted and legalized.

(h) *Jordon Creek, Honey Creek Township, Vigo County.* An act was passed on January 15, 1846, to define, deepen, change and alter the channel and levee the banks of Jordon Creek, Honey Creek township, Vigo county.

(i) *Turtle Creek, Sullivan County.* Turtle Creek in Sullivan county is an unimportant affluent of the Wabash. It had no well defined channel and during times of high water valuable lands were overflowed for a considerable distance from the parent stream, and troublesome and serious sickness produced. An artificial channel, called the canal, had been devised to remedy this mischief, but it performed its functions inadequately and on January 19, 1846, an act was passed providing for the definition of the channel of this stream between two designated points and the construction and maintenance of an artificial channel with which the one already constructed was incorporated.

(j) *Wabash River, Honey Creek and Prairie Townships, Vigo County.* Several unrecorded efforts had been made to redeem the riparian lands along the Wabash river in Honey Creek and Prairie townships, in Vigo county, by the erection of an embankment. This embankment had fallen into disrepair and no longer conformed to the meanders of the stream. Accordingly an act was passed on Feb. 16th, 1848, designed to authorize the repair, enlargement and straightening of this levee between two designated points and to provide for the construction of additions and extensions thereto.

(k) *Peru and Upper Peru Prairie, Miami County.* An act was passed on Dec. 22, 1849, providing for the drainage of Peru Prairie in Miami County by constructing a ditch

between two designated points, and removing the obstructions from Lafountain's Creek below the point of its intersection with the ditch. The provisions of the same act were extended to Upper Peru Prairie, an intimate and contiguous part of the same non-arable territory.

(l) *Reason W. Prather.* One of the most curious legislative enactments of this entire period was that of January 15, 1851, which authorized Reason W. Prather of Bartholomew county to construct a ditch across the state road leading from Columbus in Bartholomew county to Rockford in Jackson county in order to drain certain low lands. Prather was required to do all the work, bear all the expense and account for all damages sustained.

(m) *Cannelton Levee and Draining Company.* The last of this series of special acts, providing for the incorporation of the Cannelton Levee and Draining Company was approved on January 21, 1851. This company was authorized to construct a levee around that portion of the town of Cannelton which was subject to inundation from the highest freshets of the Ohio river and its tributaries, to build suitable dredging machines and to install sluiceways to discharge the water which might accumulate within the levee. The capital stock was fixed at $20,000; the incorporation was to run fifty years unless sooner dissolved by its own voluntary action; and it was entitled to 10 per cent. on the original cost of the work, above operating expenses and upkeep. The owners of all lands and buildings within the area of the highest flood and protected by the levee were assessed to defray the cost and expenses.

2. The County Drainage Acts. The eight county drainage acts, providing for the reclamation of swamp or waste lands within fourteen designated counties, including Vigo, Tippecanoe, Montgomery, Clinton, Warren, Carroll, White, Spencer, Allen, Vanderburgh, Cass, Pulaski, Fulton and Adams and extending over a period of a quarter of a century, from 1827-1852, may be briefly summarized. On several occasions prior to 1820, road districts had been author-

ized to use a portion of their road fund to remove obstructions from streams and rivers and to effect an improvement in navigation. In conscious imitation of this procedure, an act was passed in 1827 to enable the citizens of Vigo county to appropriate their entire road fund, not to exceed one-half of the labor due to each road district, and such contributions and donations as might be made for the removal of stagnant water from any part of that county. In 1832, the drainage of swamp lands was authorized in Tippecanoe, Montgomery, Clinton and Warren counties when it was necessary to cross adjoining lands to secure an outlet. This was the first time in the history of drainage legislation that the right of eminent domain was directly invoked. In 1835, the benefits of this act were extended to Carroll and White counties, in 1838, Thomas Gale and others who wished to drain the low lands around Center Lake, northwest of Angola, in Steuben county, were authorized to avail themselves of its provisions and in 1841, it was extended to Spencer county. According to the provisions of these acts all expenses and damages were paid by the applicant, and he was required to bear the entire cost of construction and maintenance. In 1846, a similar act was passed providing for the drainage of swamp lands in Allen county; in 1848, relief was extended to the owners of non-arable lands in Vanderburgh, Cass, Pulaski, and Fulton counties, and in 1850 the last of the series of county drainage acts extended the provisions of the act of 1848 to Adams county.

The State Wide Drainage Acts Passed Between 1852-1913. From 1852-1913, inclusive, 118 drainage acts and resolutions have been passed, sixteen of which, pertaining to highways, and to the Kankakee and Calumet rivers and the Prison North and the House of Refuge, will be considered in another connection. For convenience of treatment the remaining one hundred and two acts may be divided into the following classes: Incorporated drainage associations, Unincorporated drainage associations, Drainage of cities,

Streams and natural water-courses, Maintenance and repair of drains, Inter-State drains, Protection of fresh-water lakes, Sanitary and drainage districts, and certain miscellaneous drainage acts.

1. Incorporated Drainage Associations. Laws designed to authorize the incorporation of drainage associations for the construction and maintenance of levees, drains and breakwaters, and the improvement and repair of natural streams and water courses and previously constructed drains, have been in operation since 1852, and for eleven years this was the only way in which drainage was promoted. Since 1911, the provisions of this act apply exclusively to levees. From 1893 on for a dozen years, the formation of drainage districts where lands required a combined system of drainage was in vogue.

2. Unincorporated Drainage Associations. The method of reclaiming land which has been most widely and extensively employed is by voluntary and unincorporated drainage associations. The authority to establish drainage works resides in the boards of county commissioners and the circuit and superior courts, and this authority is invoked on petition of certain public officers and of any interested person or group of persons. The administrative organizations empowered to determine the necessity and feasibility of any proposed drainage project and recommend the distribution of assessments for benefits and damages have differed considerably, but two distinct and well defined types have gradually evolved. From 1863-1905 this function was performed by three disinterested Viewers, appointed by the board of county commissioners. The present plan was instituted in 1881, and completely superseded the older method in 1905, when a consolidation of the drainage acts was perfected. The present act provides for a county drainage board consisting of an experienced county drainage commissioner, appointed biennially by the board of county commissioners, one commissioner appointed from the township in which the proposed drainage system

is located, and the county surveyor, who is ex-officio a member. This board combines skill and experience with familiarity with local conditions, and insures disinterested unity of action.

3. Drainage of Cities. Some twenty laws have been passed providing for the drainage of cities. These laws are designed to extend the authority of the municipality beyond its corporate limits, to authorize the construction, maintenance and repair of drains and levees and the removal of obstructions from streams and to empower adjoining cities to enter into agreements to promote systems of drainage which are mutually advantageous.

4. Streams and Natural Water-Courses. Natural streams and water courses both promote and retard drainage. When they are shallow, sluggish, obstructed and tortuous, they constitute a menace, but their improvement and utilization has often been more economical and advantageous than the construction of artificial channels. To capitalize this asset, acts have been passed at various times providing for the dredging, straightening, changing of the course or the removal of obstructions, drift and debris from the channels of such non-navigable streams and the erection of protecting walls to secure the adjoining lands from piratical and predatory intrusions of the water.

5. Maintenance and Repair of Drains. The earliest laws made no provision for the maintenance and repair of public drains, and it was only when the channels had become choked and obstructed and when the lands once redeemed had relapsed that the matter was given serious consideration. The work of maintenance and repair has sometimes been entrusted to the county surveyor and sometimes to the several township trustees. The method of distributing the necessary labor by proportionate allotments has usually been employed, but contracts for the entire work are sometimes sold. Open, hand-dug ditches are usually repaired annually or biennially; dredge ditches are

cleaned at intervals of five years or when a petition for that purpose is filed by the interested persons.

6. Interstate Ditches. The earliest laws imposed a serious handicap on citizens of the state owning non-arable lands adjacent to state lines, and this barrier to effectual drainage was not removed until 1891 when the construction and maintenance of inter-state drains by mutual cooperation of the citizens of both commonwealths was provided for and the procedure in such cases was not fully perfected until 1913.

7. Protection of the Fresh Water Lakes. The powerful conservation movement of the last few years, combined with less worthy motives, led to the passage of a law in 1905 providing for the protection of the fresh water lakes of the state and the maintenance of their natural level.

8. Sanitary Districts. The General Assembly of 1913 authorized the incorporation of a sanitary and drainage district in Lake county whenever a majority of the qualified resident electors of the proposed district vote favorably on the proposition at a special election to be held for that purpose. This district, when organized, will cooperate with other similar districts in the contiguous counties of Illinois to promote a combined system of inter-state drainage and sewerage by means of the natural outlet through the Illinois river. The management of the district is entrusted to a board of five trustees, elected every four years.

9. Miscellaneous Drainage Acts. A multitude of miscellaneous drainage laws enacted during the past twenty-five years have perfected and effectualized the drainage code by affording relief in cases where the ambiguity of the statute fomented controversy and litigation, providing for the disposition of excess drainage funds, and the cancellation of unused drainage assessments, prescribing the duties of county surveyors in certain cases, making malicious injury done to drainage works a public offense, authorizing the reclamation and purchase of the submerged

lands bordering on Lake Michigan, providing for the construction of flood-gates to obstruct the retrograde action of water during floods and freshets, authorizing the establishment of tributary drains communicating with and discharging their waters into previously constructed drains, and providing for the tiling of existing public open drains.

THE NEWER AND MORE NOTABLE PROVISIONS OF THE STATE DRAINAGE LAWS.

A detailed study of the various state drainage laws is manifestly impossible in an abridged treatise. Besides, there is a certain uniformity in all these statutes and their composite, essential and irreducible provisions are sufficiently described in the Model Drainage Law, a study of which appears elsewhere in this Bulletin. Among the newer, exceptional and more notable provisions the following are worthy of enumeration.

THE AUTHORITY TO INITIATE DRAINAGE. The establishment of public drains for the reclamation of agricultural lands depends invariably on the application of a certain designated per cent of the interested owners, usually a majority. In Oklahoma, if the drain is designed primarily for the benefit of the public health, the signatures of 15 per cent. of the owners, owning 15 per cent of the land, is sufficient. In Ohio, if the State Board of Health finds that a drain is necessary for sanitary purposes, the County Commissioners make the necessary surveys and perfect plans and when these plans are approved by the State Board, the Commissioners proceed with the construction. The New York Conservation Commission is authorized to undertake drainage enterprises on its own initiative if they are of sufficient importance to warrant the interference of the state. The County Commissioners of the several counties of New Mexico are authorized to levy and collect a tax, not exceeding one mill on the dollar, to be expended in the drainage of swamp lands, flooded districts, or stagnant marshes which are a menace to the public health. Any county in Kentucky is authorized to remove stagnant water or reclaim marshes that may cause sickness and defray the expense out of the county revenue, or any part of a

county may be created into a separate taxing district for that purpose.

PUBLIC SUBSIDIES. In South Carolina, if the public health is seriously affected by the condition of any water-course, improvements may be undertaken on application of one-third of the owners, residing within two miles of the stream and two reputable physicians, one of whom practices in the neighborhood and if the cost of the betterment cannot be reasonably borne by the interested owners, the excess is charged to the county and paid out of the general revenue. In New Jersey, if the cost of constructing any drainage works exceeds the benefits to the lands affected, the excess is raised by general taxation.

CO-OPERATION WITH THE UNITED STATES GOVERNMENT. During the last half dozen years, several states, including Georgia, South Carolina, and Maryland, have provided for co-operative action with the United States Government in the promotion of drainage enterprises.

CENTRALIZED SUPERVISION. The following states maintain drainage boards of varying and unequal degrees of merit which are authorized to exercise their functions throughout the entire commonwealth: Minnesota, Texas, Illinois, New York, Florida, California, South Dakota, Oregon, Louisiana, New Jersey, Kansas, Washington and North Carolina.

The State Board of Drainage Commissioners of Florida is authorized to supervise the construction of drains anywhere throughout the state, to prepare lists of unreclaimed alluvial and swamp lands, and to levy a tax of not to exceed ten cents per annum per acre to defray all expense involved. The Conservation Commission of California is empowered to accumulate information on the subject of drainage and reclamation. In South Dakota all of the larger drainage enterprises must be approved by the State Engineer. The State Land Board of Oregon is authorized to contract for the drainage of lakes, marshes and swamps and to sell the lands when reclaimed. Beginning with 1913,

the petition for any drainage enterprise in the state of Wisconsin must be accompanied by a favorable report of the State College of Agriculture on the quality of the soil, the feasibility of drainage and the probable costs and benefits. The Board of Managers of the Geological Survey of New Jersey, on application of at least 5 interested land owners, are authorized to examine the designated swamp tracts, make the necessary surveys, and adopt a system of drainage and report to the state supreme court. In Kansas, all plans of reclamation are submitted for approval to the School of Engineering of the State University or the Agricultural College. In 1913 the state of Washington created a Department of Agriculture. Among other duties, this Department is required to make surveys and classifications of such lands as are in need of reclamation and Agricultural Development Districts may be created to effect their redemption. In South Dakota all work is done under the supervision of the State Engineer and in North Carolina the engineer of any local drainage enterprise is appointed on recommendation of the State Geologist.

SERVIENT DISTRICTS. Several states, including Illinois and Idaho, provide for the articulation of upper and lower or servient drainage districts in order to secure adequate outlets and develop progressively larger drainage units.

OWNERSHIP OF MACHINERY. The statutes of several states provide for the purchase of dredge machines by drainage districts or corporations. In Delaware, this policy is determined by two-thirds vote of the persons interested, and in Wisconsin on petition of a majority of the owners.

COUNTY DRAINAGE BONDS. At the general election of 1914, a constitutional amendment will be voted on by the people of Michigan permitting any county to issue bonds to raise money for the construction of drains and the improvement of agricultural lands.

COUNTY DRAINAGE COMMISSION. In South Carolina, upon request of a majority of the senators and representatives

of any county, the Governor appoints not less than three nor more than five resident freeholders as County Drainage Commissioners, for terms of four years. These Commissioners exercise control over all the drains of the county; they may require owners through whose lands private drains pass to connect these drains with a public ditch in harmony with the general system of the neighborhood, provided the cost does not exceed one-fourth of the land value; if lands are in an unsanitary condition, they may require the owners to drain them if the cost does not exceed one-half their value; in carrying out any of these enterprises, they may utilize the chain gang of the county to do the work.

WATER POWER. Invariably under the newer laws all water power which results from the construction of a drain is the property of the district and may be appropriately utilized.

THE PRESENT STATUS OF THE INDIANA DRAINAGE LAW.

A study of the Indiana Drainage laws prior to 1903 is unprofitable except to those who are interested in sheer antiquarianism. The General Assembly of that year adopted a resolution providing for a codification of these laws and the first comprehensive act was passed two years later, in 1905. This performance was repeated in 1907, and since that time the drainage acts have grown steadily in number and confusion. The chief source of this confusion lies in the fact that successive legislatures adopt amendments which have overloaded the statutes with endless verbiage, introduced a multitude of subjects into one section, and seriously impaired their self-consistency. The chaotic condition of the drainage laws in this state finds an unenviable counterpart in the drainage laws of Missouri before their reconstruction in 1909. The laws of that commonwealth proved an inextricable puzzle to laymen, attorneys and contractors and even confounded the Supreme Court itself, the members of which failed to agree as to the meaning of certain important sections. This unfortunate condition created an impasse, frustrated justice and seriously retarded the effective and expeditious execution of the law; and finally the position of the chief tribunal became so embarrassing that members of the court expressed themselves in favor of an immediate and thoroughgoing rearrangement.

This evolution by successive accretion has led in many states to the indefensible method of adopting as many as six separate and distinct systems for accomplishing the same result. It would be as logical and sensible to employ an equal number of systems in the administration of the public schools, the control of corporations or the collection and disbursement of public revenue. The dual system has worked best in practice and is supported with practical unanimity

by all drainage and hydrographic experts. One system should provide for the organization of districts by the county courts or boards of county commissioners, and the other for the incorporation of districts by the circuit courts. The selection of the alternative should be left to the voluntary action of the applicants or petitioners. The laws as administered by the boards of county commissioners have usually been found to be more economical and expeditious, but those administered by the courts have obvious and incontestable advantages.

Under the present law, all drainage enterprises, except the construction of dykes and levees, are entrusted to a commission, consisting of the county drainage commissioner appointed biennially by the county board, the county surveyor and a special commissioner selected from the township wherein the drain is located. These commissioners locate and establish all drains and assess benefits and damages. Drains are established on petition of the interested owners, filed with the county commissioners, or with the circuit or superior court if the drain crosses a county line. Any proceeding may be quashed by a remonstrance signed by two-thirds of the persons interested. The work of construction is supervised and the assessments collected by a superintendent of construction appointed by the board. Repairs are made by the township trustee, or the county surveyor on petition of the owners subject to assessment.

SUGGESTIONS FOR LEGISLATION.

In order to perfect an adequate and comprehensive drainage and reclamation plan, this state should adopt a modern, scientific, up-to-date drainage and levee law; it should provide for the appointment of a capable and experienced State Engineer; and it should prohibit the construction of levees and drains in any part of the state which do not coördinate with and form an integral part of a carefully perfected plan.

1. A NEW DRAINAGE LAW. In order to secure a satisfactory and practicable drainage act, this state should adopt the so-called Model Drainage Law which is described in detail elsewhere in this Bulletin. This law was drafted by a corps of competent engineers, it was endorsed by the National Drainage Congress, recommended by the Department of Agriculture, and is being rapidly adopted by all the important swamp land states of the Mississippi valley and the South. It is simple, workable and easily understood, and all dilatory restrictions have been eliminated. Its constitutionality has been invariably upheld. It is equally applicable to the construction of drains or levees and to large as well as to small enterprises. The approved features of the present drainage law should be incorporated with and preserved as a part of the new statute. The adoption of a standardized drainage law will vigorously promote cooperation among the states.

2. A STATE ENGINEER. In a second statute, the State should provide for the appointment of an engineer who should be a capable and experienced topographer and skilled in the science of road building. The functions and duties of a State Highway Commissioner and a State Drainage Engineer could be discharged by the same officer, who would be the central disbursing agency for all moneys derived from

the appropriations for post roads and the redemption of waste lands, now under contemplation by Congress. Without a duly authorized receiving and disbursing agency, the state will be excluded from this important source of revenue. In his capacity as State Drainage Engineer, this officer and his assistants, should be required to make a comprehensive topographical survey of the state. The order in which the surveys are undertaken should be left to the discretion of the State Engineer and made to depend on certain practical contingencies such as the expediency and feasibility of the contemplated project, whether the community has taken the necessary steps to organize a drainage district, or whether there is an immediate necessity for the survey. In this way the water-shed of the Kankakee or the Wabash or any other intrastate stream could be surveyed and mapped as a single unified project. The territory comprising the water-shed could then be divided into districts susceptible of adequate drainage or reclamation by a single system of drains or levees, and a plan with appropriate specifications worked out and preserved for each district. As rapidly as drainage associations were formed for the reclamation of these independent districts, accurate scientific data would be available, and the separate units could be developed at any time and in any portion of the territory, but always in accordance with the plans of the general drainage system of which it would form a part, and when finally completed the main drains and the tributary drains would be adjusted to each other, overlapping and duplication would be avoided, and the outlet would always be adequate for each added increment of water. The engineer should also be required to furnish accurate scientific data to any county or drainage association applying for the information and no county or drainage district should be permitted to undertake a drainage or reclamation enterprise until the plans were inspected and approved by the State Engineer.

3. Flood Control and River Improvement.—In perfecting and executing plans for drainage, reclamation, flood con-